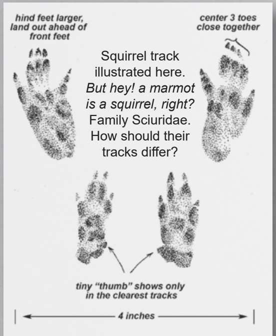
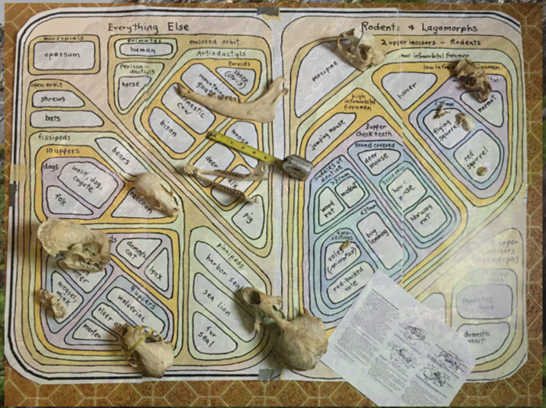
Mammals

Richard Carstensen
Discovery Southeast





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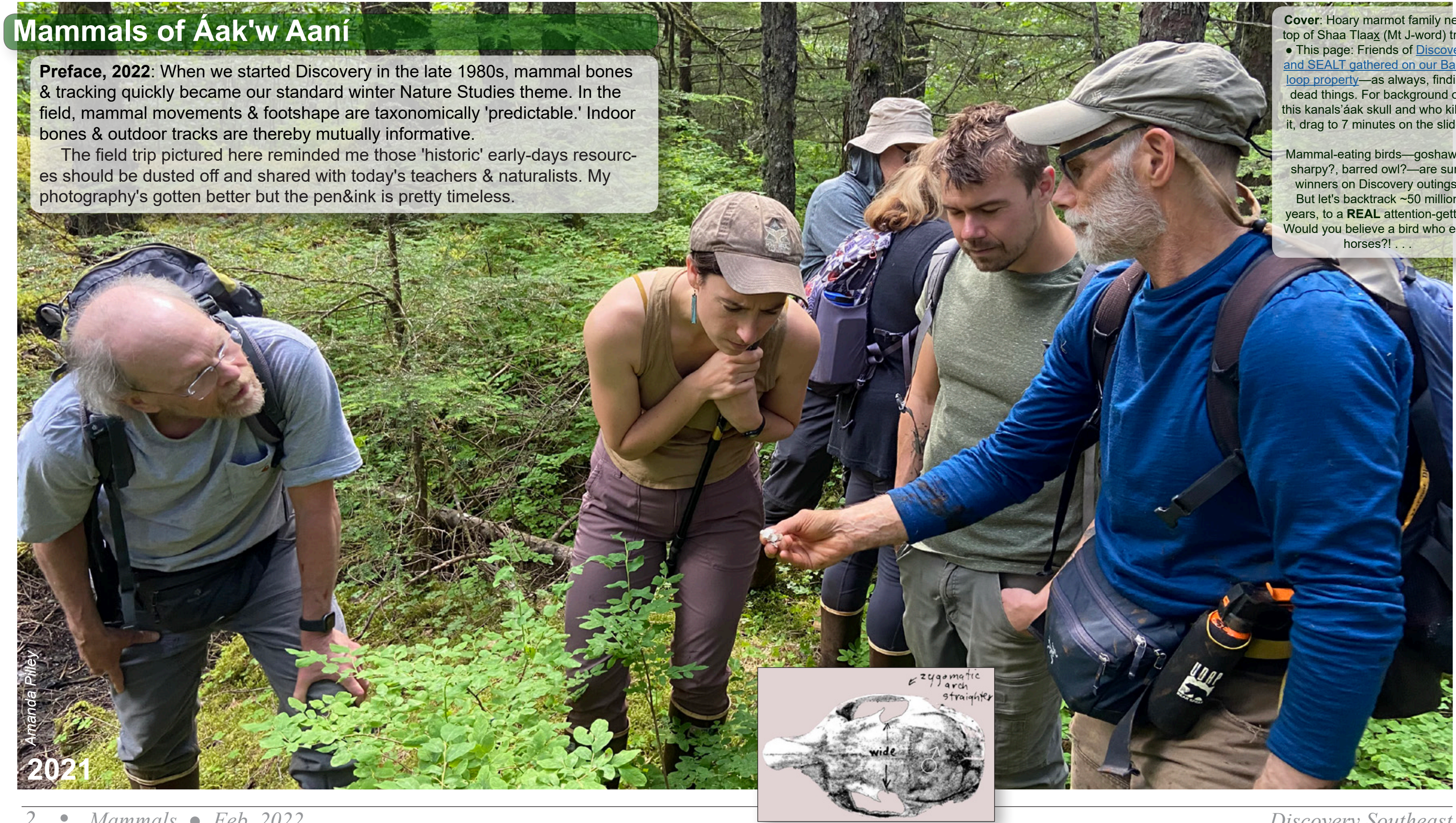
Mammals of Áak'w Aaní

Preface, 2022: When we started Discovery in the late 1980s, mammal bones & tracking quickly became our standard winter Nature Studies theme. In the field, mammal movements & footshape are taxonomically 'predictable.' Indoor bones & outdoor tracks are thereby mutually informative.

The field trip pictured here reminded me those 'historic' early-days resources should be dusted off and shared with today's teachers & naturalists. My photography's gotten better but the pen&ink is pretty timeless.

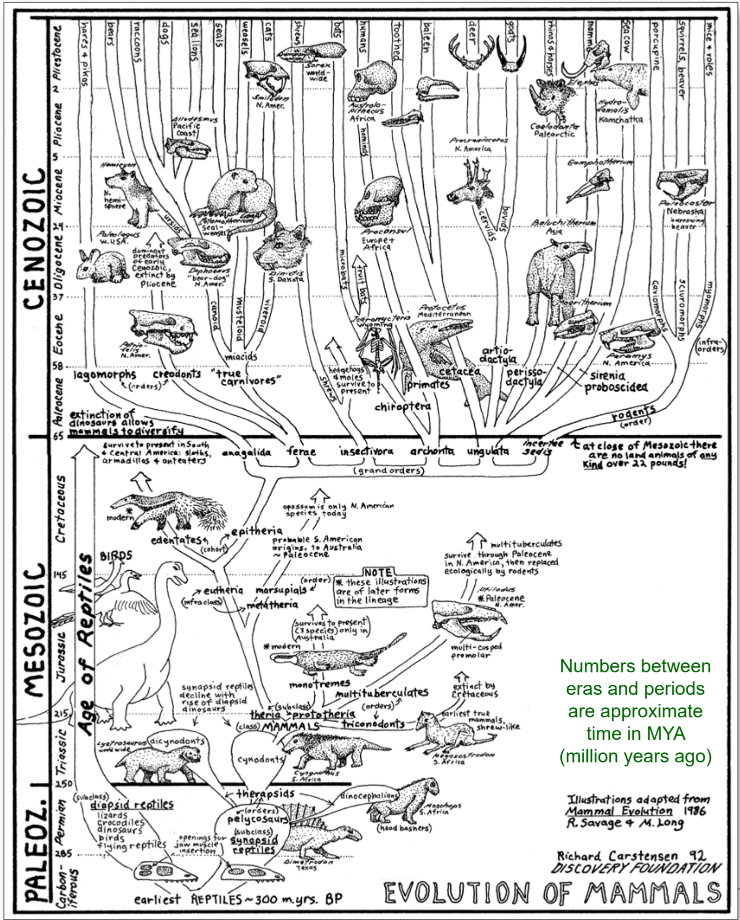
Cover: Hoary marmot family near top of Shaa Tlaax (Mt J-word) trail. • This page: Friends of Discovery and SEALT gathered on our Back-loop property—as always, finding dead things. For background on this kanals'áak skull and who killed it, drag to 7 minutes on the slider.

Mammal-eating birds—goshawk? sharpy?, barred owl?—are sure winners on Discovery outings. But let's backtrack ~50 million years, to a **REAL** attention-getter. Would you believe a bird who eats horses?! . . .



Amanda Pilley

2021

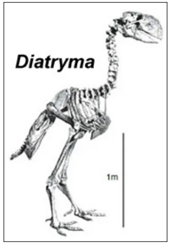


Mammal family tree

Let's start at the beginning—of Discovery, and also, of mammals . . .

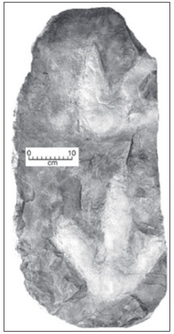
In the early 1990s, around the time Cathy and I began teaching adult Discovery workshops on Southeast mammals, my hometown, Rochester, New York, brought a wondrous exhibit to the city's museum. Visiting my parents over several Christmas holidays, I made evolution my winter study, inspired largely by the Science Center's displays. They featured lifesized mid- to early-Cenozoic monsters—creodont bear-dogs, ancestral sabretooths, and bellycrawling swamp-whales.

Today, 30 years later, what most sticks in mind is a towering Diatryman 'terror-bird', about to devour some ineffectual-looking proto-horses. Jurassic Park (1993) was hitting theatres just as Brylinski, Merli, Lubin and I were reaching our own bipedal stride, encouraging Alaskan students and teachers to think of ***everything as a track***. It seemed to me that Stephen King and Jurassic animators were missing the boat by 100 million years or so. Dinosaurs were cool, I supposed, but early radiation of birds and mammals was hot!

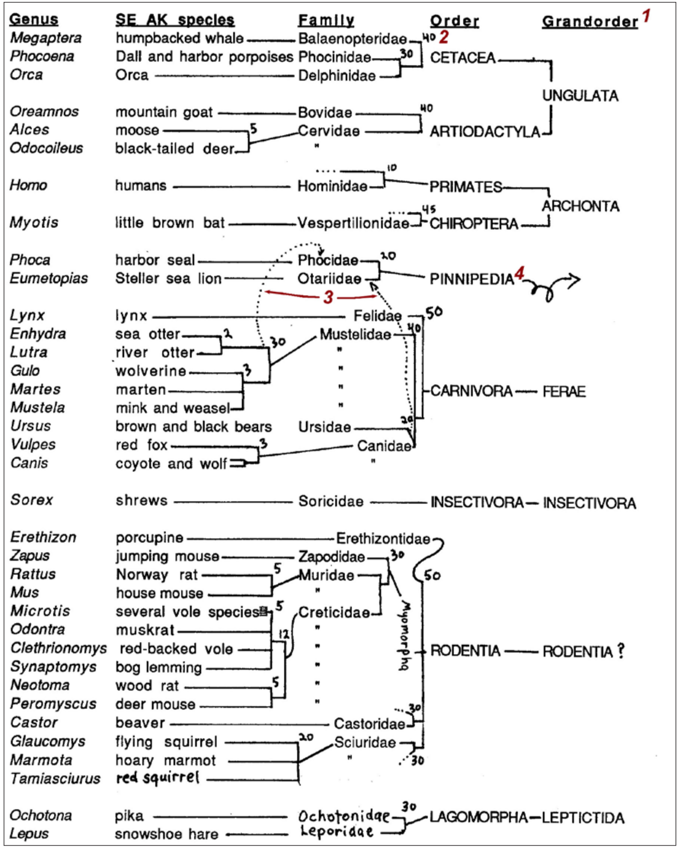


There's been a lot of paleontological uprooting and prognostication since then. If there's anything more fun than horse-eating birds, it's dueling dignitaries and academic guerilla warfare. Checking in on the status of my South American avian frankenstein, I see she's been demoted or at least impugned. In 2012, *Wired* ran a piece titled *Eocene big bird not so scary, after all.* It involved not only fossil reinterpretation but ***actual bird tracks***, exposed in lower Eocene sandstone by the famous fatal 2009 mudslide in Whatcom County, Washington. Diatryma probably just ate plants. Hmmmph!

Granted, Cascadia is slightly south of Discovery's turf, but mass wasting we got in spades! How could any North Pacific slide-zone naturalist resist sniffing around in *that?* No beak-mangled horses? No problem!



Gastornithid tracks from Racehorse Slide, Chuckanut Formation, WA. Plantigrade form & absence of claw impressions or hallux imprints. From Mustoe *et al* (2012). Velociraptor this was regrettably not. But I'd eagerly restore *Diatryma*, if her genes turn up in lower Eocene amber. *:)*



Genus>family>order

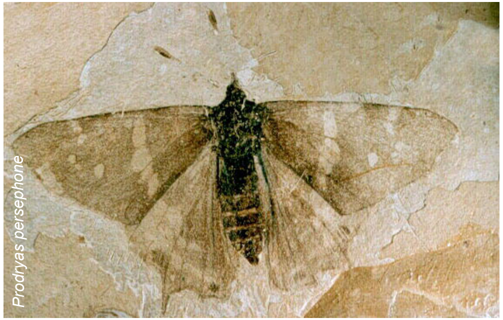
While the illustrated tree on preceding page grows upward, this one's tipped sideways, older to the right, and radiating to the left from common ancestors. Rather than ranking by geologic era>period >epoch, these are grouped taxonomically, with differently timed divergences. That said, those split-off periods do correlate with the progressively finer familial groupings. Today's genera date back only to the Pliocene, whereas orders we recognise in the third millennium were widespread much earlier in the Cenozoic.

Creating trees, tables, and mammal-maze/dichotomous key, I've mostly purged taxa not found currently in Lingít Aaní. But as with *Diatryma*, everything we know about relationships and evolution of our native NW-coast mammalian relatives was learned not here but elsewhere in North America. Pre-Pliestocene vertebrate fossils are so far undocumented in the glacier-ploughed archipelago. Much older **in**verts—meso-&-paleozoic—abound in some Southeast bedrock units but tell nothing of local history because the ***rocks themselves came from elsewhere***.

There's one potential exception, from Mio-&-Oligocene rocks laid down *en situ*—*ie*, not rafted here from subtropical latitudes before even dinos swam or crawled. Before glaciers sliced us into an archipelago, many of the bizarre ancestral mammals on my preceding illustrated tree ***did*** doubtless roam arcto-tertiary forests on rolling hills above what we know today as Angoon and Kake. Kayaking by, I've loitered to 'paleobotanize'—slipping my knifeblade into fragile and semiflexible mudstones, twisting em open to reveal delicate impressions of veined leaves more diverse than arboreal flora of today's temperate-deciduous China or Smoky Mountains. This 2009 sample was

Left: 'Sideways tree'
1 Grandorders show possible Paleocene derivations, and are very speculative.
2 Numbers at branchings give time in MYA (millions of years ago) when groups probably diverged.
3 Dotted lines show probable origins.
4 Pinnipedia is an artifical order containing two convergent families.

Right: Leaf fossils from behind Angoon. Finest-grained mudstones preserved best detail of leaf veins—and theoretically, mammal bones?.



found on a day outing with JoAnn George into Xunyéi, *north wind tidal currents* (Mitchell Bay). I've long wanted to camp there for a week, prospecting for bone-prints of marsupial 'wolverines,' or pony-sized, shovel-jawed mastodonts. So far, only leafprints have been documented here from these epochs. [1]

Oddly enough, it was a book about butterflies (Williams, 2020) that most recently renewed my enthusiasm. (Bear with me; this actually does turn back to mammals.) Turns out, the world's most perfect butterfly fossil—*Prodryas persephone*—was preserved in Eocene sediments from Colorado, from my lay-perspective almost identical to our Angoon rocks. The butterfly graced these incompletely lithified strata alongside 10-foot-diameter redwood logs, 3-toed horses, brontotheres, and proto-pig oreodonts:

> *"A shallow lake, lasting millions of years, covered the land. . . [*into which*] the perfect little butterfly slowly sank. Ash layers covered it. Cell by cell, the insect turned to stone. . . .Many fossils other than this magnificent butterfly have been discovered in the lake where it fell. Overtopping layers of ash and organic matter . . . created what scientists call paper shales—ultrathin layers that are even today not particularly hard . . .*

Ahah! "*Paper shales*." Perfect name for those stone-books I've tried to read in Ch'ayáa (Big John Bay)

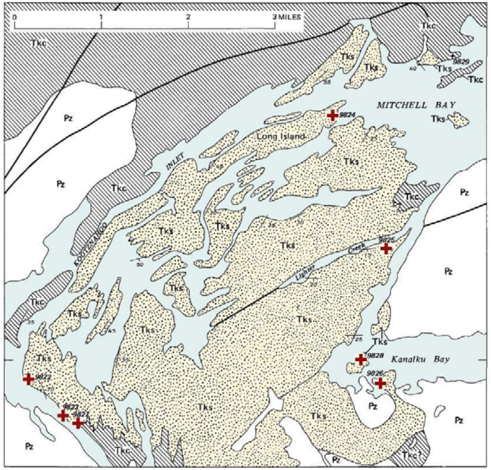
> *" . . . If you carefully break apart some of these layers you can still see the minutiae of life preserved on the lake bottom—even details of fish scales . . . stem joints of horsetail, and pollen identifiable to species."*

I'm not necessarily recommending you go to Angoon or Kake and start ripping apart rocks. It's a weird feeling, watching the impression of an unidentified leaf unfold into the light of day for the first time in over 30 million years, oily and glistening . . . only to dessicate and crumble before your eyes. Makes pedestrian vandalism seem respectful.

I didn't have the preservatives or skills to properly archive or share those leaves, *or*—should they have emerged—much rarer skeletal remains. It's probably better for trained archivists to direct our search for the ultimate winners of Alaskans' favorite contest; '*i-been-here-longer-than-you.*' Could anything top (or, superpositionally, I spoze it'd be *under*lie) the mudcast of a slightly flattened but articulated Miocene *Paleocastor*?

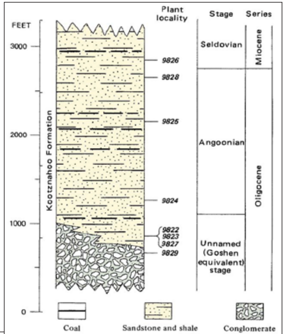
Well okay, a viveroid-miacid Oligocene *Dinictis* could out-native *Paleocastor* by a few million years

1 *Admiralty impressions: Xutsnoowú through time*. Discoveries newsletter #7, Fall 1997. Downloadable from JuneauNature's newsletters page.



Generalized geologic map of part of Kootznahoo Inlet. Data from Lathram and others (1965). Tks (stippled) is the sandstone and shale part of the Kootznahoo Formation; Tkc (lined) is conglomeratic part; Pz, undifferentiated Paleozoics. Heavy lines represent faults. Crosses represent plant localities.

From Jack Wolfe's marvelous paper on Paleogene floras. (Wolfe, 1977). In the late 90s, I wrote him at USGS headquarters, Menlo Park (on actual stamped paper). Never heard back. Perhaps Jack saw from my query that I was more excited about potential vertebrates than his beloved Arcto Tertiary leaves.



Generalized stratigraphic section of the type area of the Angoonian Stage.

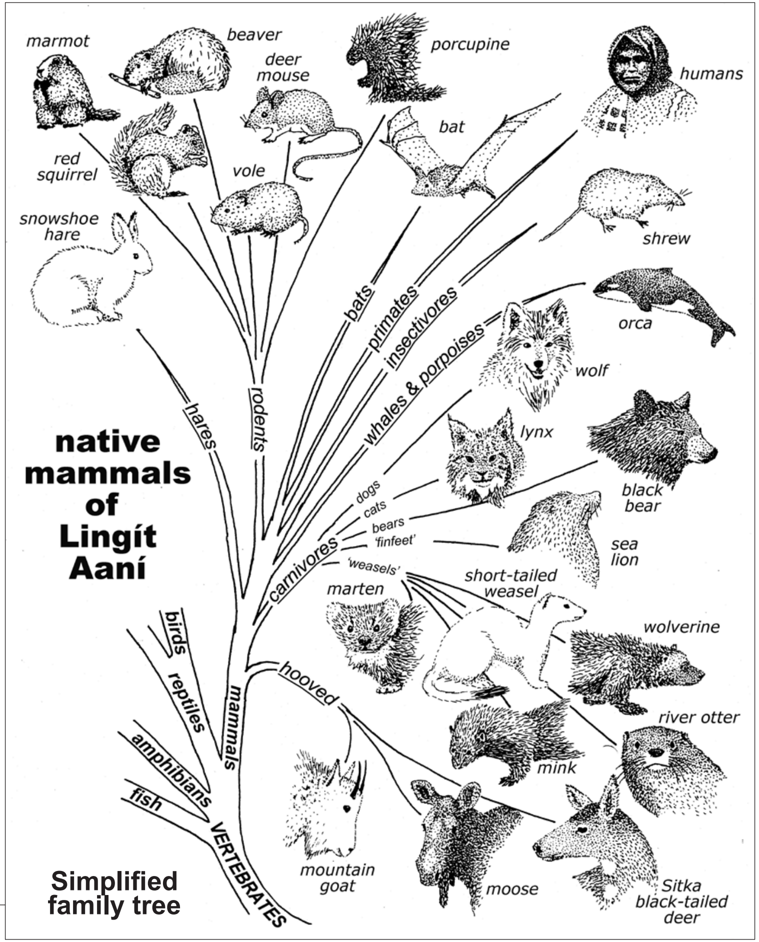
Distribution of Southeast mammals

Geographic categories in these tables are further explained in the text. **Ubiquitous**: Mainland and nearly all major islands. **Mainland & isles**: Widespread on mainland and many but not all of largest islands. **North & interior**: Interior species entering Southeast, especially in the north. **Southern**: Postglacial recolonization from the south. **Oddballs**: Distribution doesn't fit these other patterns (*subsp* are island subspecies, not tallied in total counts). **Intros**: Species introduced by people. More complete treatment of mammal biogeography is found in Cook and MacDonald's *Recent Mammals of Alaska* (University of Alaska Press, 2009).

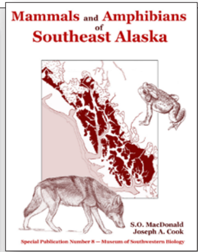
Species	Ubiquitous	Mainland & isles	North & interior	Southern	Oddballs	Intros
RODENTS						
flying squirrel		◆				
hoary marmot		◆				
arctic ground squirrel			◆			
red squirrel		◆				
beaver	◆					
meadow jumping mouse			◆			
western jumping mouse				◆		
brown lemming			◆			
long-tailed vole	◆				*ssp*	
tundra vole					◆	
meadow vole		◆				
southern red-backed vole				◆		
northern red-backed vole			◆			
bushy-tailed woodrat			◆			
muskrat		◆				
Keen's (deer) mouse	◆				*ssp*	
western heather vole					◆	
bog lemming		◆				
house mouse						◆
brown rat						◆
porcupine		◆				
LAGOMORPHS						
collared pika			◆			
snowshoe hare			◆			

From Carstensen Armstrong & O'Clair (2014)

In 2014, Bob Armstrong and I made extensive upgrades to *The nature of Southeast Alaska*, 3rd edition. One of the sections I spent most time on was *Mammals*—in part because so much had been learned since our book's first edition in 1992. Distribution tables on this and next page are one result. Distributional data were largely from the work of Steve MacDonald & Joe Cook, whose grad-student teams have canvased Southeast with snaptraps, murdering, preserving and mapping those cryptic & overlooked voles, shrews and bats. ● Endemism is rife in island archipelagos, albeit only incipient in geologically young ones like ours. 'MacD&C's' multidecadal work has become central to discussions of conservation, connectivity, and biogeography of Lingít Aaní.



Species	Ubiquitous	Mainland & isles	North & interior	Southern	Oddballs	Intros
SHREWS						
Glacier Bay water shrew					?	
cinereus shrew		◆				
dusky shrew		◆				
water shrew		◆				
BATS						
silver-haired bat	?					
California myotis	◆					
Keen's myotis	◆					
little brown myotis	◆					
long-legged myotis	?					
hoary bat	?					
CARNIVORES						
lynx			◆			
mountain lion			◆			
house cat						
coyote			◆			
wolf		◆				
domestic dog						
red fox			◆			
black bear		◆				
brown bear		◆				
wolverine		◆				
river otter	◆					
American marten		◆				
Pacific marten					◆	
fisher			◆			
ermine	◆					
least weasel					◆	
mink	◆					
raccoon						?
HOOVED						
moose		◆				
elk						◆
Sitka black-tailed deer	◆					
caribou			◆			
mountain goat		◆				
Dall's sheep			◆			
57	10	17	15	2	4	4

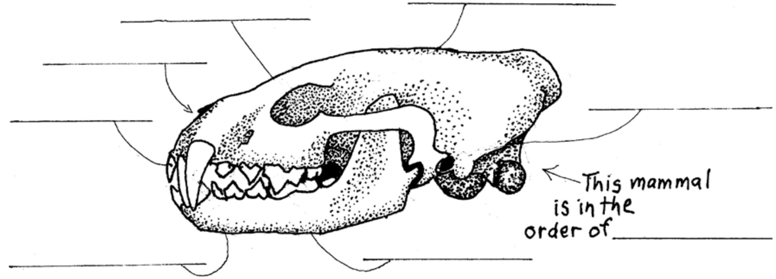


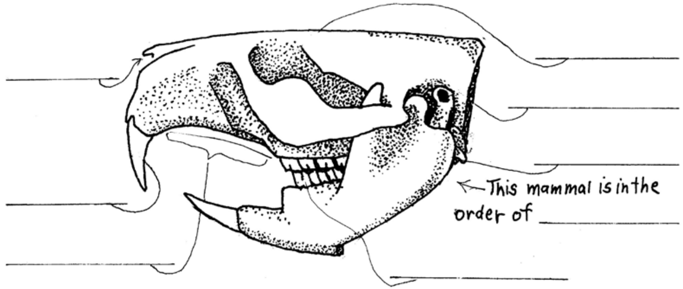
Steve & Joe's 2007 publication should be in every Southeast naturalist's library—at least as a pdf. A 5MB low-res but fully serviceable version is downloadable from the Mammals category page on JuneauNature. The full-res is kinda large (242MB) to post to Discovery's cloud drive. If you want that version, bring a plug or card by the office and make yourself a copy.

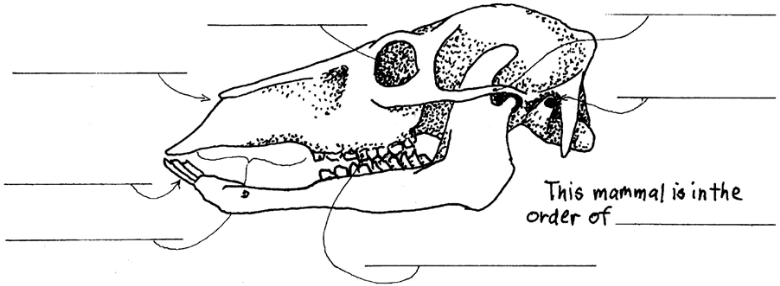
Two years after their SEAK mammals book, 'MacD&C' published *Recent mammals of Alaska* (2009). It carries over almost everything in the 2007 Southeast-specific document and might be preferable to folks with statewide interests. Maps in the 09 pub give less room to SE AK, so collection dots are harder to read, and the amphibian section is dropped. A true geek, of course, has both publications.

Features limiting distribution of our terrestrial mammals include heavy rains, deep winter snows, geographical barriers such as the ice-draped coast ranges, dissecting rivers, and wide marine channels. Another feature is time. Except for occupants of a few ice-free outer-coast refugia, all mammals were evicted from Southeast during the great ice age. The intervening 12,000 years have not yet allowed recolonization by all that *could* live here. Subterranean homebodies like moles and ground squirrels and pocket gophers are conspicuously missing; our only true burrower is the hoary marmot, and it is found only on the mainland and nearly-connected Sayéik (Douglas Island).

Thanks to decades of work by Joe, Steve and next-gen colleagues such as Natalie Dawson, we have pretty good range maps for Southeast Alaska's terrestrial mammals. How and when they reached specific islands, and which isolated forms represent distinct subspecies, are still under investigation. This table categorizes mammals geographically, in ways that provide clues to points of origin and means of dispersal. More thoughts on these categories are on pages 92-100 of *Nature of SE AK* (2014).



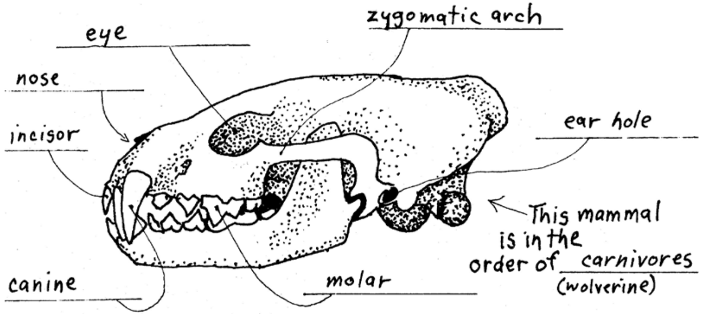


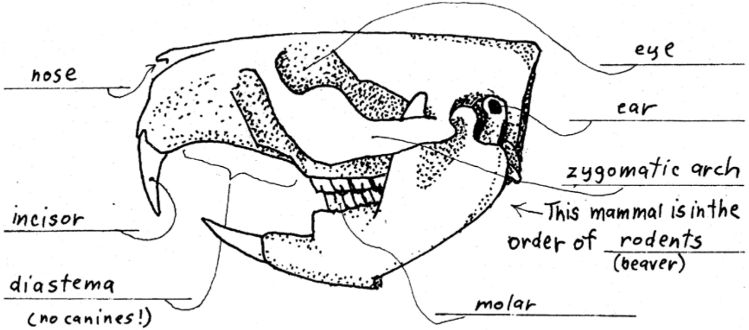


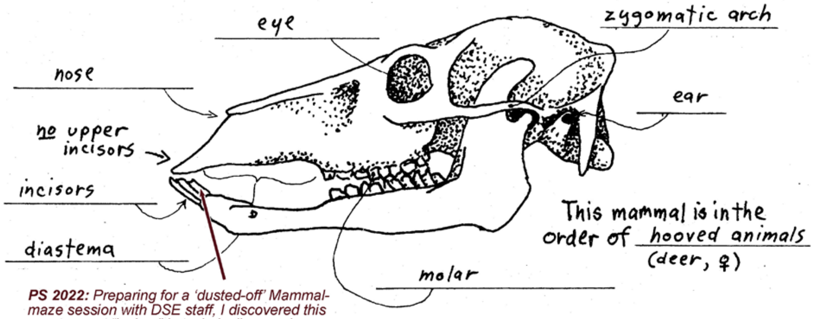
Mammals of Southeast Alaska
Richard Carstensen

Names of teeth and skull parts

Comparing mammals of 3 different orders







PS 2022: *Preparing for a 'dusted-off' Mammal-maze session with DSE staff, I discovered this outermost "incisor" is technically a canine.*

Mammals of Southeast Alaska

Richard Carstensen

(Teachers' cheat sheet)

Names; teacher version

A great deal more background in skull morphology and taxonomy can be learned from the following dichotomous key.

Mammal-maze

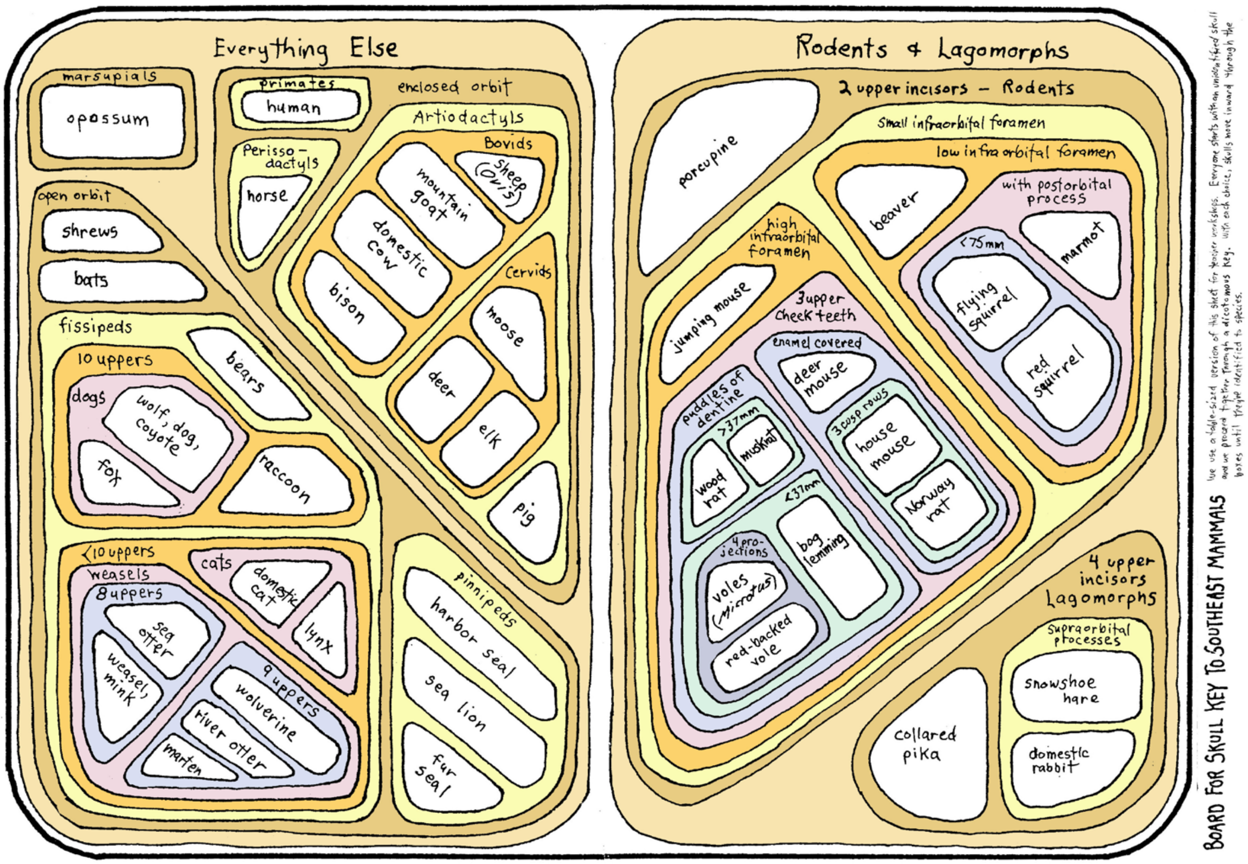
Board for following skull key. Bess Crandall and I have printed out a table-sized version. There's several ways to play with a group, but here's one scenarion.

Everyone picks an interesting skull from DSE's collection. Doesn't matter whether you know what it is. Arrange skulls along perimeter of the maze.

Read aloud choices **1a** & **1b**. If your skull has no canines it'll stay put until question 30.[1] Meanwhile, help folks with canine skulls as we read questions **2a** vs **2b** . . . then **3a** vs **3b**, and so forth, each time advancing skulls inward.

It's best, starting out, for everyone to focus together on an example of the #2choices, 3choices, etc. Eventually, once the process is clear to everybody, can split into smaller teams, proceding at your own pace. Can either print copies or share the key as pdf on players' phones.

Keep a ruler or tape measure handy.



1 Alternatively, with several leaders, could split into 2 groups: canines *vs* diastemas.

Skull key for Southeast mammals

Adapted from an artificial generic key to skulls (except Cetacea) in *Mammals of the Pacific* (1965) by Lloyd Ingles. Edited for native Southeast Alaskan genera, a few introduced mammals, and some important North American mammals that kids always ask about.

Numbers in ***bold-italic*** refer to *Figures*. Numbers preceded by .... direct you to the next a-b pair. Thus "....6" means go to 6a and select between it or 6b.

This key separates mammals only to genus (latin name italicized). Conveniently however, most Southeast genera are represented by single species. Exceptions: shrews (*Sorex spp.)*, bats (*Myotis spp*.), bears (*Ursus spp*.), dogs (*Canis spp*.), 'weasels' (*Mustela spp*.) and voles (*Microtis spp., Myodes spp*.). The abbreviation *spp*. designates multiple species in a genus. In the case of genera with only one local species, common name is given. Other possibilities may exist elsewhere.

Toothrow formulas: #upper ICPM / #lower ICPM [1]

1a no canines; long diastema between upper incisors & cheek teeth; skull length <6in; orbit not enclosed posteriorly. rodents or lagomorphs (hares & pikas) ***5&6***....30

1b with or without canines; when canines are absent, skull >6in; diastema if any is shorter than canine; orbit may be enclosed in a bony case ***13***....2

2a <50 teeth; <5 incisors on each side of upper jaw....3

2b 50 teeth; 5-1-3-4/4-1-3-4 order Marsupialia *Didelphus*, **opossum** (not in SE)

3a skulls with orbit enclosed posteriorly (except some pigs). orders Primates, Artiodactyla (even-toed) &

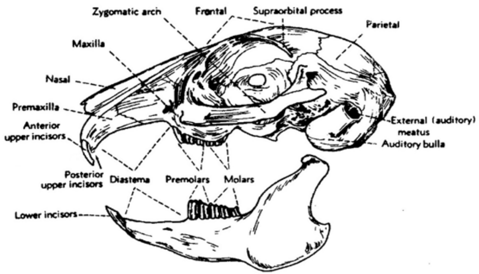


Fig. 5. Side view of the skull of a brush rabbit (Lagomorpha), showing the small upper incisor teeth behind the larger ones and some of the bones of the skull.

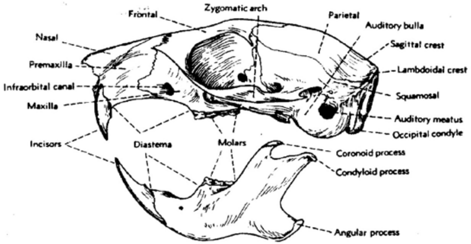


Fig. 6. Side view of the skull of a Douglas squirrel (Rodentia), showing teeth and bones of the skull.

Perissodactyla (odd-toed) ***13***....4

3b skulls with orbit opening posteriorly (not enclosed by union of postorbital process with zygomatic arch; orbit also enclosed in some cats) ***12***....13

4a orbits facing forward; rostrum very short, making face nearly vertical: 2-1-2-3/2-1-2-3 order Primates *Homo*, **humans**

4b orbits facing laterally; rostrum elongated....5

5a without prominent lateral lambdoidal ridge; cheek

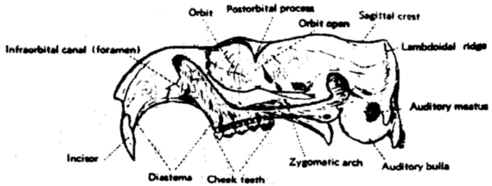


Fig. 12. Lateral view of the cranium of a yellow-bellied marmot (*Marmota flaviventris*) showing orbit open posteriorly and other features. It is a representative of the rodent Suborder Sciuromorpha.

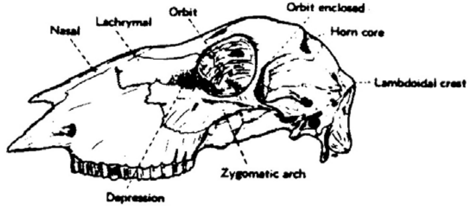


Fig. 13. Lateral view of the cranium of a female domestic sheep (*Ovis aries*) showing the lachrymal bone in contact with the nasal bone.

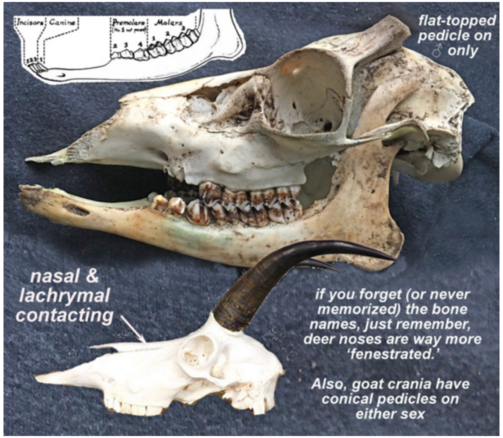
teeth selenodont or lophodont ***15***, canines, If present, shorter than upper incisors....6

5b large skull with prominent lateral lambdoidal ridge; canines longer than incisors; turned outward and triangular in section; cheek teeth bunodont ***16***; 3-1-4-3/3-1-4-3 order Artiodactyla. *Sus*, **domestic pig**

6a large skull with upper incisors present; face very long; cheek teeth lophodont; 3-1-4-3/3-1-3-3 order Perissodactyla *Equus*, **horse**

6b large skull without upper incisors; face long; cheek teeth selenodont (with crescents), order Artiodactyla....7

1 ICPM = incisors-canines-premolars-molars



7a lachrymal bone ***13*** in contact with nasal bone; horns in both sexes; Bovidae....8

7b lachrymal bone ***14*** not contacting nasal bone; antlers only in males; Cervidae....11

8a cheek teeth row >4.25in; skull >14in....10

8b cheek teeth row <4.25in; skull <14in....9

9a horns not black; >6" circum; *Ovis*, **mountain sheep**

9b horns black, sabre-like; <6" circum; *Oreamnos*, **mountain goat**

10a large skull with premaxillary extending to nasal; from above, forward zygomatic arch not obscured by frontal bone; horn core with conspicuous boss (knob-like swelling at base); 0-0-3-3/3-1-3-3 *Bos*, **domestic cattle**

10b large skull with premaxillary not extending to nasal; from above, forward zygomatic arch obscured by frontal bone; horn core without conspicuous boss;

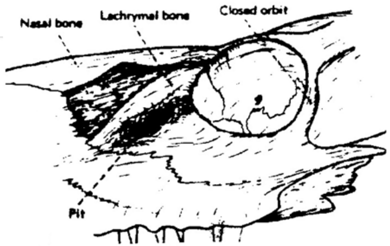
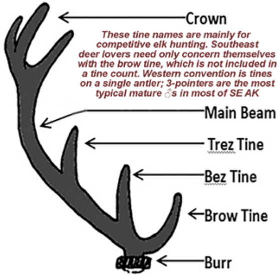


Fig. 14. Lateral view of a part of the cranium of the mule deer (*Odocoileus hemionus*) showing the large lachrymal pit and the lachrymal bone not contacting the nasal bone.



0-0-3-3/3-1-3-3 *Bison*, **bison** (not in SE)

11a antlers palmate; skull >20in; *Alces*, **moose**

11b antlers cylindrical: skull <20in....12

12a brow & bez tines present: upper canines present: upper cheek teeth row >4.2in; 0-1-3-3/3-1-3-3 *Cervus*, **elk**

12b ♂ bez tines absent, brow tines variable: upper canines absent; upper cheek teeth row <4.2in; 0-0-3-3/3-1-3-3 [2] *Odocoileus*, **Sitka black-tailed deer**

13a incisors (except first 2 large ones) run longitudinally down skull ***17***; canines = or <unicuspid incisors; order Insectivora *Sorex*, **shrews**

13b incisors slightly arched, or set transversely across skull ***18***....14

14a skull >1.25in; Carnivora & Pinnipedia (artificial suborder; seals & sea lions)....17

14b skull <1.25in; order Chiroptera (bats)....15

15a 6 upper cheek teeth; broad U-shaped anterior emargination of palate; 2-1-3-3/3-1-3-3 *Myotis*, **little brown bat** (& several other species in SE)

15b <6 upper cheek teeth. *Lasionycteris*, **silver-haired bat**

17a some teeth sectorial (flesh-cutting) ***24***; or all with flat human-like

2 2022: I was puzzled by that lower row—3-1-3-3—which suggests deer (and also goat 9b) have a lower canine. Inset drawing, extreme upper left, explains that the outside tooth in that forward 'incisor row' is actually a canine.

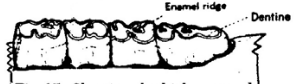


Fig. 15. Showing the high-crowned selenodont-type teeth of the domestic horse (*Equus caballus*) with enamel ridges.

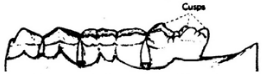
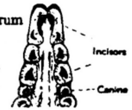


Fig. 16. Showing the low-crowned bunodont-type teeth of a domestic pig (*Sus scrofa*) with cusps.

Fig. 17. Ventral view rostrum of the Trowbridge shrew incisors arranged longitudinally. (Some consider shrew canine to be a premolar.)



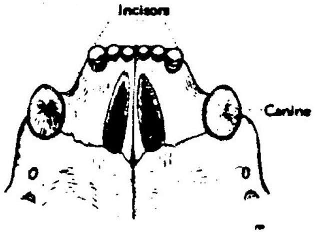


Fig. 18. The incisors are arranged horizontally across the cranium in a mountain lion (*Felis concolor*).

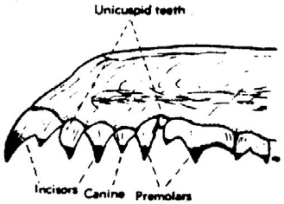


Fig. 19 Lateral view of the rostrum of the Trowbridge shrew (*Sorex trowbridgii*). (Some consider the canine to be a premolar.)

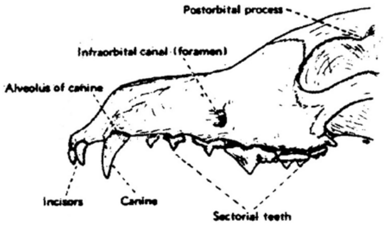


Fig. 24. Lateral view anterior part of cranium of coyote (*Canis latrans*) showing the sectorial cheek teeth.

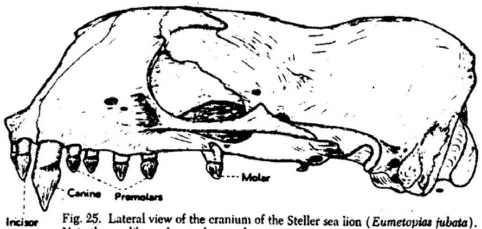


Fig. 25. Lateral view of the cranium of the Steller sea lion (*Eumetopias jubata*). Note the peglike molars and premolars.

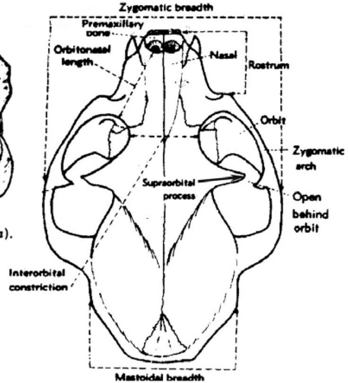


Fig. 26. Dorsal view house cat (*Felis domestica*

crowns; never <3 lower incisors on each side (except sea otter, with 2); suborder Fissipedia (artificial group of non-marine carnivores)....18

17b cheek teeth all peg-like with single conical crowns ***25***; or each with 3 cusps in a line; never >2 lower incisors on each side; suborder Pinnipedia (artificial, seals & sea lions)....28

18a zygomatic width **26** >5.5in, 42 teeth; crowns of cheek teeth low & human-like (bunodont) 3-1-4-2/3-1-4-3 *Ursus*, **bears (brown & black)**

18b zygomatic width <5.5in, or if more, with <32 teeth....19

19a 10 upper teeth on each side....20

19b <10 upper teeth on each side....22

20a upper tooth row <2in; *Procyon*, **raccoon**

20b upper tooth row >2in: Canidae (dog family)....21

21a upper tooth row >3.5in (except small dog breeds); postorbital process thick and convex on dorsal surface; 3-1-4-2/3-1-4-3 *Canis*, **wolf, coyote, dog**

21b upper tooth row <3.5in: postorbital process thin, concave dorsal surface; 3-1-4-2/3-1-4-3 *Vulpes*, **red fox**

22a upper molar (last cheek tooth or m^1) small, <1/2 size of last premolar ***28***; total teeth <30 Felidae (cat family)....23

22b upper molar >1/2 size of last premolar; teeth >32. Mustelidae (weasel family)....24

23a 2 upper premolars (3 cheek teeth); 3-1-2-1/3-1-2-1 *Lynx,* **lynx**

23b 3 upper premolars (4 cheek teeth); 3-1-3-1/3-1-2-1 *Felis*, **mountain lion & domestic ca**t. orbit usually open but may be closed posteriorly

24a 9 upper teeth on each side....25

24b 8 upper teeth on each side....27

25a skull >5.5in; sagittal crest extending >3/8in behind lambdoidal ridge; 3-1-4-1/3-1-4-2. *Gulo*, **wolverine**

25b skull <5.5in; sagittal crest not extending behind lambdoidal ridge....26

26a mastoid breadth >2.4in ***26***; diameter of infraorbital foramen >diameter of alveolus of canine ***24***; first molar wider than long, rhomboid-shaped; 3-1-4-1/3-1-3-2 *Lutra*, **river otter**

26b mastoid breadth <2.4in; diameter of lnfraorbital foremen <diameter of alveolus of canine; first molar about 2/3 as wide as long, rhomboid-shaped; 3-1-4-1/3-1-4-2 *Martes*, **marten**

27a skull >4in; *Enhydrus* **sea otter**

27b skull <4in; *Mustela*, **mink, weasel**

28a no distinct postorbital process on frontal bone; upper incisors pointed; Phocidae, *Phoca*, **harbor seal**

28b distinct postorbital process on frontal bone; upper incisors transversely notched on crown; Otariidae (family of eared seals)....29

29a space between premolars and molar (last tooth) as wide as a premolar; 3-1-4-1/2-1-4- 1 *Eumetopias*, **Steller sea lion**

29b space between premolars and molar (last tooth) not as wide as a premolar; 3-1-4-1/2-1-4-1 *Callorhinus*, **northern fur seal**

30a 4 upper incisors (2 small

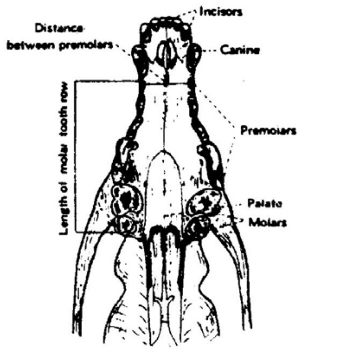


Fig. 27. Ventral view coyote (*Canis latrans*) limits of measurements distinguishing coyote from dog skulls.

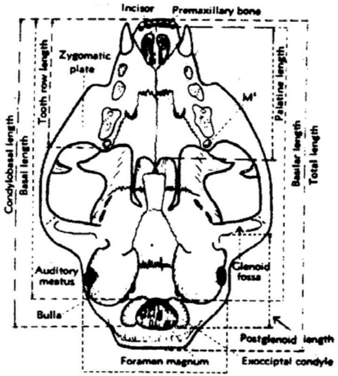


Fig. 28. house cat's skull (*Felis domestica*) on a total length extends from extreme anterior to extreme posterior.

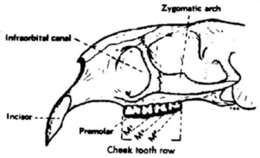


Fig. 31. Lateral view of the anterior part of the cranium of the porcupine (*Erethizon dorsatum*), a representative of the rodent Suborder Hystricomorpha.

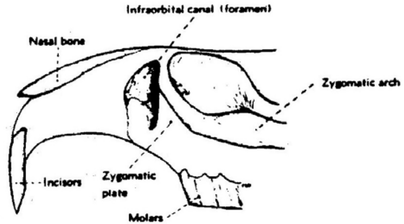


Fig. 32. Lateral view of the anterior deer mouse (*Peromyscus maniculatus*), Suborder Myomorpha

peg-like teeth behind outer ones); order Lagomorpha....45

30b 2 upper incisors; order Rodentia....31

31a infraorbital foramen ***12*** <foramen magnum....32

31b infraorbital foramen >foramen magnum; nasals extend far posterior to premaxillary bones; front side of incisor red or yellow; *Erethizon*, **porcupine**

32a infraorbital foramen low on zygomatic plate or rostrum ***12***; its greatest diameter <width across base of 2 upper incisors; suborder Sciuromorpha (squirrels, marmot, beaver)....33

32b infraorbital foramen high on rostrum on inside of zygomatic plate **32**; its greatest diameter >width across base of 2 upper incisors; suborder Myomorpha (mice, voles, muskrat, woodrat)....37

33a without postorbital process on frontal bone *Castor*, **beaver**

33b with postorbital process on frontal bone ***12***; Sciuridae (squirrel family)....34

34a skull <3in; usually not concave between ends of nasals & crown....35

34b skull >3in; clearly concave between ends of nasals & crown; usually with distinct sagittal crest posteriorly **12**; 1-0-2-3/1-0-1-3 Marmots, **hoary marmot**

35a zygomatic arches bulge outward at mid-length & flattened side to side; 1-0-2-3/1-0-1-3 *Glaucomys*, **northern flying squirrel**

35b zygomatic arches nearly parallel, or converging toward rostrum; 1-0-2-3/1-0-1-3 *Tamiasciurus*, **red squirrel**

37a 4 upper cheek teeth; upper incisors grooved longitudinally; 1-0-1-3/1-0-0-3 Zapodidae (family of jumping mice) *Zapus*, **jumping mouse**

37b 3 upper cheek teeth; upper incisors not grooved longitudinally; 1-0-0-3/1-0-0-3 Cricetidae (in part, family of mice & voles)....38

38a 2 or 3 rows of little cusps running down crowns of each cheek tooth row; crowns not flat but generally covered with enamel and do not usually show the dentine; if dentine does show, it is then not enclosed in triangles....39

38b without rows of little cusps running down crowns of each cheek tooth row; crowns flat with little triangles or 'puddles' filled with dentine and surrounded by enamel....41

39a with 2 rows of cusps running down the crowns of the tooth row **35**; Cricetidae, *Peromyscus*, **deer mouse**

39b with 3 rows of cusps running down crowns of tooth row; Muridae (Old World mice & rats, introduced to Southeast)....40

40a incisive foramen extending posteriorly to level of middle of first molar; skull <1.2in; 36 *Mus*, **house mouse**

40b incisive foramen extending posteriorly to level of forward edge of first molar; skull >1.2in; **37** *Rattus*, **Norway rat**

41a skull >1.5in....42

41b skull <1.5in; subfamily Microtinae (in part, voles, bog lemmings)....43

42a skull <2.2in; *Neotoma*, **wood rat**

42b skull >2.2in; *Odontra*, **muskrat**

43a last upper molar with 4 projections on lingual (tongue) side ***45***....44

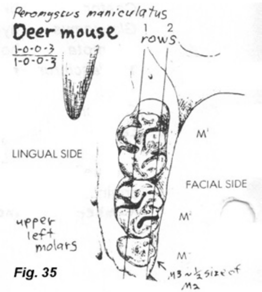


Fig. 35

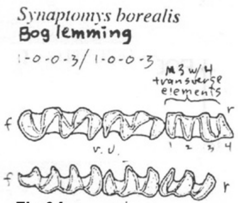
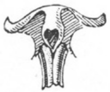


Fig 34


view of upper incisors of bog-lemming to show grooved incisors and projecting outer edge of incisors.

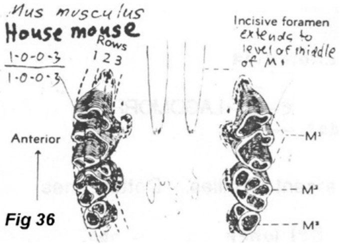


Fig 36

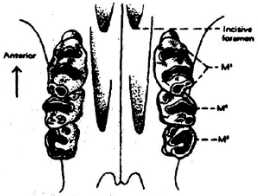


Fig. 37. Crown view of the upper molars of the black rat (*Rattus rattus*) showing the shape of the three longitudinal rows of cusps.

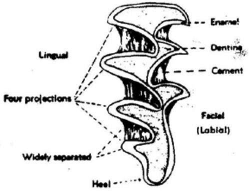


Fig. 42. Crown of the last left upper molar (M^3) of the California meadow mouse (*Microtus californicus*).

43b last upper molar with 4 transverse elements on crown ***48***; 1-0-0-3/1-0-0-3 *Synaptomys*, **bog lemming**

44a last 2 projections on lingual side of last upper molar may be closely appressed ***45***; re-entrant angle between them usually deeper than wide; without projecting 'heel' on 3rd upper molar; 1-0-0-3/1-0-0-3 *Myodes*, **red-backed voles** (2 species)

44b last 2 projections on lingual side of last upper molar wide open; re-entrant angle between usually wider than deep 42; with projecting 'heel' on last upper molar; 1-0-0-3/1-0-0-3 *Microtus*, **meadow voles** (4 species)

45a large supraorbital processes on frontal bones ***51***; 6 cheek teeth on each side of upper jaw; sides of rostrum (maxillary bones) conspicuously fenestrated 'lacework.' Leporidae (family of hares and rabbits)....46

45b without supraorbital processes on frontal bones; 5 cheek teeth on each side of upper jaw; sides of rostrum not conspicuously fenestrated; 2-0-3-2/1-0-2-3 Ochotonidae (pika family) *Ochotona*, **collared pika**

46a interparietal bone never distinct (in adults) from parietals; upper cheek teeth row usually >1/2in; 2-0-3-3/1-0-2-3 *Lepus*, **snowshow hare**

46b interparietal bone separated in adults by distinct sutures from parietals ***51***; upper cheek teeth row between .4 &.5in; 2-0-2-3/1-0-2-3 *Sylvilagus*, **domestic rabbit**

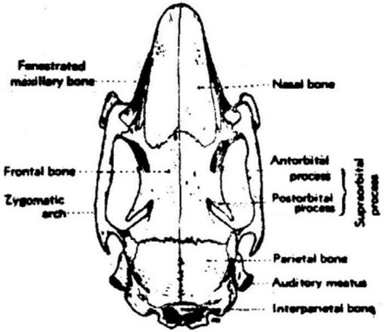


Fig. 51. Dorsal view of Audubon cottontail (*Sylvilagus audubonii*).

Fig. 43. Crown of the second left upper molar (M^2) of the meadow mouse (*Microtus pennsylvanicus*) showing five loops.


Fig. 44. Crown of the second left upper molar (M^2) of the long-tailed meadow mouse (*Microtus longicaudus*) showing four loops.

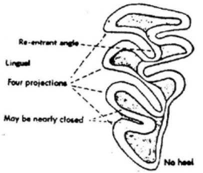
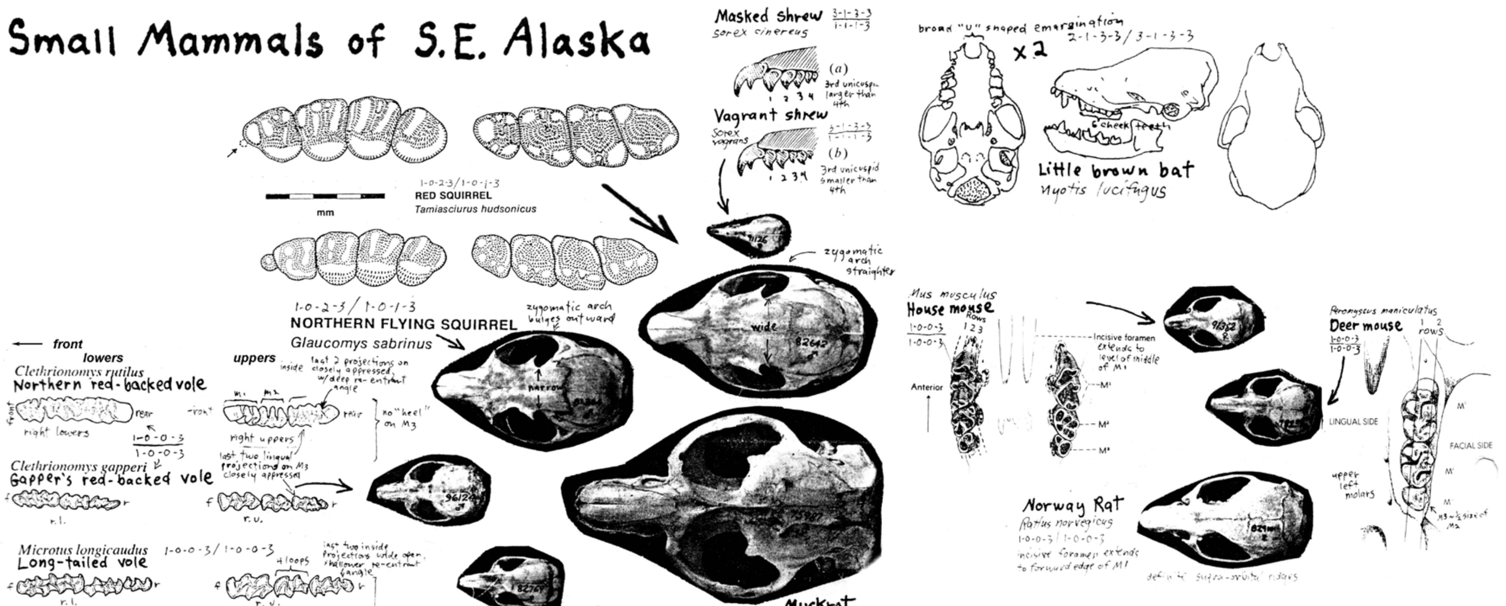


Fig. 45. Crown of the last upper left molar (M^3) of the Western red-backed mouse (~~Clethrionomys occidentalis~~).
PS 2022: now Myodes


Fig. 48. Crown of last upper left molar (M^3) of the bog vole (*Synaptomys borealis*)



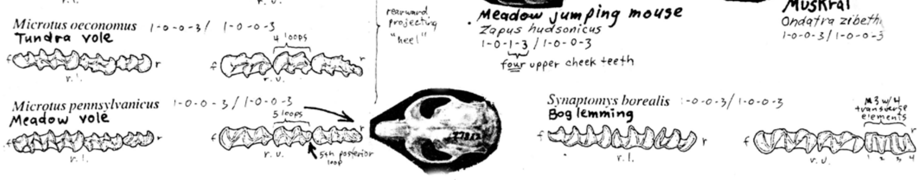
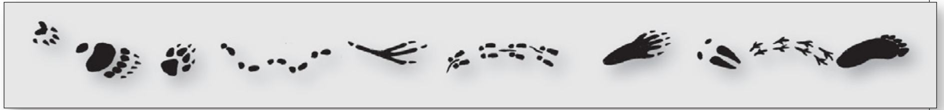


Fig. 15. Front view of upper incisors of bog-lemming to show grooved incisors and projecting outer edge of incisors.

Rodents bats & shrews

2022: I seem to have lost the original paste-up copy-master for this page, so for now we'll make do with this kinda anemic version. As with preceding board and skull-key, it's mostly derived from Ingles (1965)

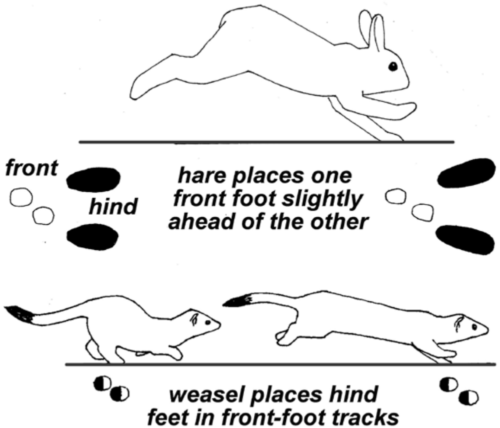


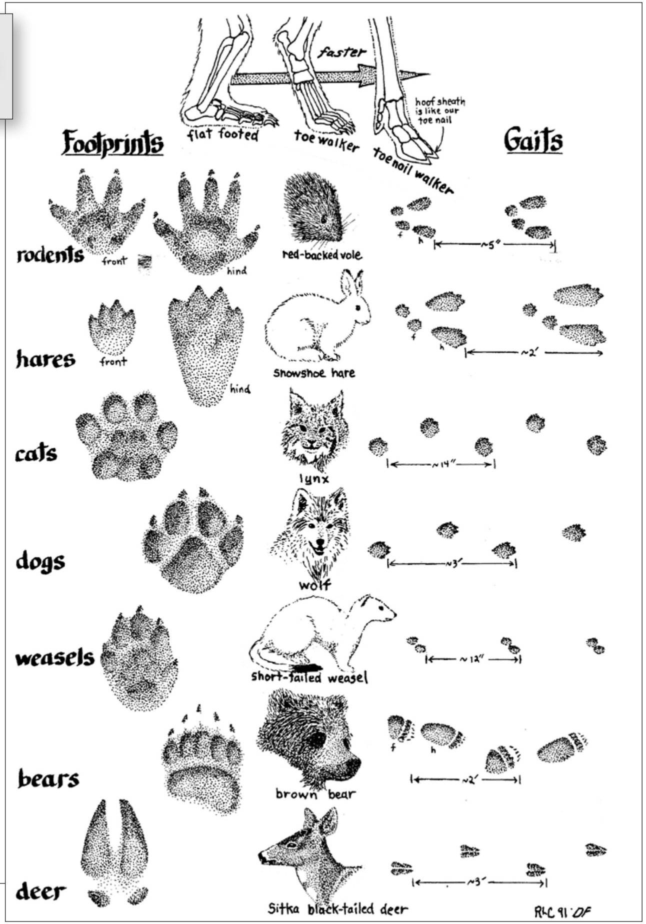
Appendices

1 Prints & gaits

To be expanded . . . .

Meanwhile, download Discovery's tracking booklet from JuneauNature. Makes a nice pocket guide, but if you keep the pdf on your phone, it'll always be with you.



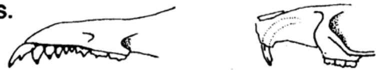


2 Questions: native mammals of Lingít Aaní

Find animal #1 on the mammal family tree. Is it a rodent? _____ What is the name on its branch? ________ The snowshoe hare gnaws and hops like a rodent, but its teeth are different! Hares have tiny teeth called 'peg teeth' behind their front teeth. Circle the hare skull. Draw an arrow to the peg teeth.

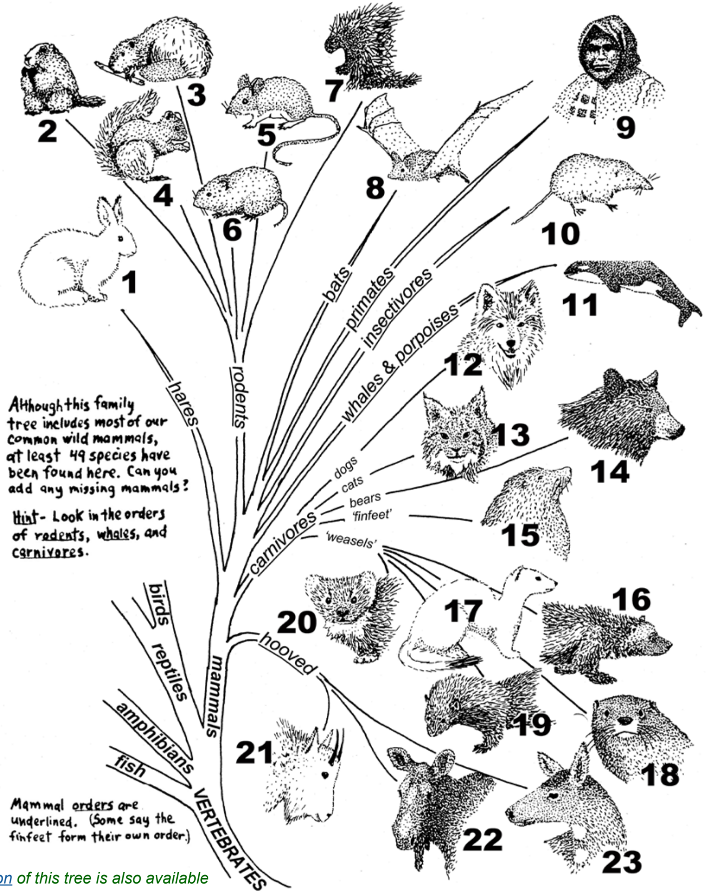
The snowshoe hare is also called the varying hare because its color varies with the seasons. What other mammals on the family tree are white? #_____ and #_____ What parts of the ermine (17) and hare are black-tipped? _________ and _________ If an owl aims at the black tip of a moving ermine's tail, the owl misses and the ermine gets away! The backs of summer ermines are brown.

Find animal #10. Is it a rodent? Like the hare, it is alone on a branch of the tree. Its branch says ______________________. That means _______________-eater. The tiny shrew has jagged teeth for crushing insects. Circle the shrew skull.



Find #5 and #6. Are they rodents? ____ Color in the long incisors on the vole skull, above. Deer mice have big eyes and ears and a long tail. Which is the vole? #___ Is the porcupine a rodent, too?_____ **"Which animals are more closely related --porcupine, vole or shrew."** Underline the two close relatives.

Which animal wears a mink coat? #___ The mink's rich fur keeps it warm in cold streams like Jordan Creek. What other animals on the tree use streams and rivers? #____ and #____.



A species-labeled, un-numbered version of this tree is also available

3 Nature-dude riff

Davey Lubin, Discovery's first naturalist at M-word River School, composed many songs on nature themes. Davey was ultra-cool and became known as the nature-dude. I can't remember what tune or beat this was set too. We'll have to ask him. Like our founding director Scott Brylinski, Lubin moved to Sitka. Big demotion for them in terms of tracking potential; Shee, *volcano woman* (Baranof Island) has woefully low mammalian diversity—not to mention sealevel outercoast snow persistence.

MAMMALIAN SHUFFLE (and friends)
(By Dave Lubin)

Rodents, rodents........... four toes on the front feet
and five behind.

Incisors that nip and molars that griiiiiiind

Canids have four toes with naaaaaaiiiiiillllllsssss that show;

Lynx have four but you only see toooooeeeee

Martens and Weasels, Miiiiiiiink and Bearrrrrrrrr

Their feet have five toes with clawwwwws and hairrrrrr.

Ducks, Geese and Otters have toes in a web...........

You can see them in the snow or when the tide is at ebb.

Oh Yeah!!!!! .... Animal tracking is really, really fun...........

You can do it in the rain, in the snow or in the sun!!!!!!!!

4 Track on the back

To summarize what we've learned about animal tracks, we'll play a game called *Track on the back*, adapted from a Joseph Cornell exercise. (We considered "*Scat on the Back*", but abstained.) You'll be able to play this with your class, simply by copying the Tracking Guide master sheets, with names of animals taped over, and then cutting em into cards to fasten to your students' backs.

There are 16 mammals and 4 birds, and it doesn't hurt to have duplicates of some for a larger group. The goal is to discover what kind of animal you have pinned to your back, by asking questions of your neighbors. Here are the rules, as established by the *Committee for Interpretive Responsibility:*

1) Ask questions of people you don't know. (no cliques!)

2) Ask only one question of each person, then go to another person.

3) Ask only questions that can be answered "*yes*", "*no*" or "*sometimes*".

4) Ask only questions about tracks (#toes, claws, size, gaits, etc.) Don't ask, for example, "*Am I bigger than a wombat?*"

5) Ask at least 4 questions before guessing the name of your animal. If you get it wrong, hop 2 laps around the classroom, (your choice of diagonal or paired front feet).

5 Teaching ideas

● Solicit names of favorite animals and write them on the board. Then circle mammals and ask for common traits (*ie* live young, hair, four limbs, lactate, breathe air, warm blooded, care for young, etc.). Systematically erase non-mammals using exclusionary statements. Then circle carnivores with red chalk, herbivores with green chalk, and omnivores with both. Ask what patterns can be seen.

● Use skulls in discussion of teeth and jaw configuration. Note range of motion of lower jaw. Carnivores have more confined up-down articulation for cutting and crushing, while herbivore jaws move easily side-to-side for grinding. Consider eye and ear location. Carnivores have front-facing eyes for binocular vision. Beaver ears are high on the head, remaining functional while swimming.

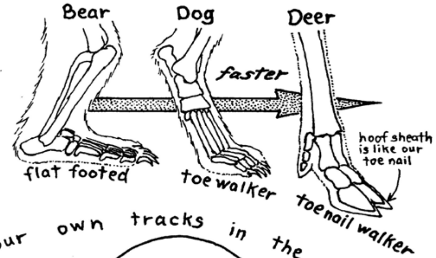
● Provide each student with a piece of jerky and a carrot. Observe how humans (omnivores) process (bite into) each; what teeth are used and how.

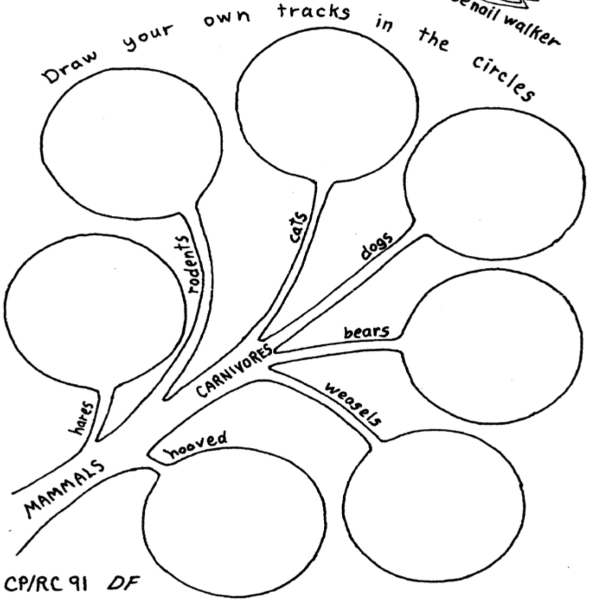
● Create gait sheets for your local mammals, refering to attached materials for models. Have students practice moving in accordance with each gait. When students are familiar enough to execute the gaits without the gait sheets, experiment with changes in speed. Note how increased speed alters stride length and straddle.

● Make collections of animal fur, bones, scat, chewed twigs, etc.

● A good summary game for a tracking unit is charades. Give a student team a scenario such as porcupine harassed by dog, or otter family rolling around on their haul-out spot. See if they can act this out, using what they've learned about gaits and movement patterns, in a recognizable fashion.

6 Footprint exercises





	hares	rodents	cats	dogs	bears	weasels	hooved
# toes	f-4, h-4	f-4, h-5	4	4	5	5	2, +dew claws
claws?	sometimes	sometimes	no	yes	yes	yes	hooves
gaits	hop	hop, walk	walk, gallop	walk, trot	walk, gallop	bound, lope	walk, gallop
other	furry feet, float on snow	large ones walk, small ones hop	claws retract, hind steps in front print	toe walkers dew claw on front foot	big toe on outside	see "rule of thumb"	fewer toes for speed, dew claws print

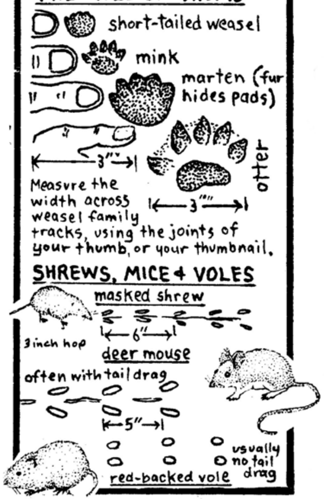
Whose Footprints?

Connect each mammal with its footprint.

TRACKING TIPS

- What habitat?
- Surface. Hard or soft?
- Age. Old or new track?

THE RULE OF THUMB



7 On the right track to wild things

Sherry Simpson, July, 1990, for *Juneau Empire*

Richard Carstensen kneels on the wet sandbar and examine the faint print pressed into the silt. Around him a dozen students step awkwardly, like strange shorebirds, as they try to avoid obliterating any other tracks along Eagle River. Rain drips from their hats as they peer down at the track.

"*Oh, neat,*" Carstensen says, intently studying the print with his nose a few inches above the ground. "*This is very interesting*."

He sketches a box around the track to isolate it and leads the students through the Socratic method of question and answer: How many toes? Can you see the claws? Which way was it headed? Does it resemble the cat prints discovered earlier, or would a cat spread its paws out this much?

The students decide "*no*" on the last question. "*So this looks like a new animal here*," Carstensen says.

Another round of questions, and the students conclude that a member of the weasel family passed by here, most likely a marten.

Add another critter to the field trip's list of finds. The students have already spent 6 hours in a classroom studying slides, diagrams, skulls and scat as part of *Animal tracking and sign*, a course offered through the University of Alaska Southeast. Now they're seeing their studies come alive on this rainy morning along Eagle River, where the mist rising from the water adds to the allure of mysteries upcovered and secrets revealed.

The students include Forest Service employees, a biology teacher, several people who just want to know more about Juneau's natural world, and a woman who wants to make real life match the confusing drawings in the guidebooks.

"*Every time I look at a track I think it looks like a javelina, and I don't really think there are too many wild pigs in Juneau*," she jokes.

No, but there's lots of other neat stuff. On this visit to Eagle River delta, the class discovers, among other tracks, pigeon-toed waddlings of a porcupine, 5-toed wanderings of a land otter, the no-nonsense stride of a deer, meanderings of a sandpiper, and fading steps of a young brown bear dubbed "*Alfreda*" by Carstensen. Alfreda spent a good part of spring in the area, but Carstensen believes she was the same bear shot recently at Tee Harbor.

Tracking instructor Richard Carstensen tells students: "Everything is a track, but not every track was made by animals."

From mountaintops to sea shores, amateur naturalists may encounter tracks or other sign left by these animals and many others, including wolves, coyotes, mountain goats, lynx, wolverines, marmots, black bears, deer, moose in some areas, marten, minks, weasels, beavers, snowshoe hares, numerous birds, and a variety of small mammals, including squirrels, mice, voles and shrews.

Some of these animals are morecommon than others, of course. But if you know where to look and more importantly, how to look, an entire world of animal life is waiting to be deciphered.

"*Tracking is really the basic skill of the naturalist*," Carstensen says. It's a skill he exercises often at Eagle River, where he has been the caretaker of the Boy Scout camp for many years and pursues his talents as a naturalist and teacher of nature-lovers.

Listen to him for a bit and it seems there is almost nothing he doesn't know about plants, animals, geology, insects and other fields of natural history, and how they all relate to each other.

Joining Carstensen as an instructor is Scott Brylinsky. Since his boyhood on the edge of the Pine Barrens in New Jersey, Brylinsky has been interested in living off the land. He moved to Juneau 10 years ago and has also amassed a thorough knowledge of the area's wildlife and plants, especially wild edibles.

Brylinsky is an internal auditor with the Department of Labor, but he spends summers teaching natural history and kayaking. His eventual goal is to live a subsistence lifestyle, without the crutch of modern technology.

A few years ago he took his first steps toward that dream when he spent a year living in the woods of Yakobi Island.

This is the pair's second year teaching tracking, but Brylinsky says neither he nor Carstensen rank themselves as experts.

"*Both Richard and I consider ourselves still students of tracking. We're just further along the learning curve. There's still a heck of lot to learn, a heck of a lot we don't know*," he says.

From their experiences in Southeast, Brylinsky and Carstensen demonstrate to the class that tracks are not limited to footprints left by animals. You can track a tree by its rings, a river by its paths, a glacier by the geological remains it leaves behind and the kind of vegetation that arises in its wake.

"*Everything is a track, but not every track is made by animals*," Carstensen says. The goal of animal tracking is not simply identifying the creature that left prints. A reading from Tom Brown's book, *The Tracker*, asks the important question: "*What does this thing have to do with everything else?*"

That means learning how the animal fits into its world, the instructors say. "*Understanding the natural history of an animal is as useful as knowing what its feet look like*," Brylinsky tells the class.

It also means gathering all clues before making a conclusion. "*Once you take a guess, you stop gathering information*," Brylinsky says.

The skilled tracker learns to identify forage and prey, understand animal behavior, figure out when and where creatures are likely to move about, and puzzle out what they were doing when they left their signs. Tracking encompasses far more than just footprints, which are not the only evidence animals leave behind. Skulls, particularly teeth, and other bones, reveal all kinds of information about animals.

"*How big was it? Try and flesh it out. What did it eat?*" Carstensen asks. "*There's a lot more interesting things than species to be found from looking at skulls.*"

The instructors lead the group through a grassy pause in the brush, where a pile of bones and skull glisten in the rain. Carstensen helps the students interpret the remains as a deer by asking what it ate, what carried it to the site, what killed it.

A lack of pedicils where antlers would grow means it's a female. Condition of teeth and an emerging molar put its age near 2½. Marks on the bones say the deer likely was killed by a hunter.

Excrement, or scat, can help identify the animal and offer clear evidence of food. Look for fish bones in otter scat, beetle parts in marten scat, berries or seeds in bear scat, for example.

Vegetation often records the passing of an animal, whether it's the gnawings of porcupines, voles or beavers on tree trunks, the browsing on silverweed or goosetongue by geese, the nibblings of deer on skunk cabbage, or the diggings for tasty roots by a brown bear.

Studying the way torn vegetation ages or tracks deteriorate can help tell when the animal was there. Other signs include beds or nests, scratches, kill remains, tunnels, middens, lodges, fur and feathers, even smells.

One of Brylinsky's favorite signs to look for is that of the land otter, partly because the playful creatures are so common along Juneau's beaches and yet so few people realize they're around. Their tracks are large enough to be mistaken for dog prints, and their scat and other signs are often obscured in vegetation.

At Eagle Beach Saturday, the naturalists led the group to a grassy riverbank and asked them to find places where otters had left the water. It didn't take long; along one short stretch otters had trampled several spots and piled vegetation into small mounds. Piles of fishy smelling scat left on the beds confirm identification.

Patterns of tracks can reveal what the animal was doing as well as what it was. In the classroom, Brylinsky crouches on hands and feet and demonstrates gaits as different species move in gallops, trots, lopes, bounds, hops, jumps and walks.

On the riverbank, he parses out the possible meaning of certain gaits by studying and measuring the distance between groups of tracks. He indicates the rear and hind feet of dog tracks with marked popsicle sticks, and then interprets the pattern.

"*That's a casual gait. It's not alarmed. It's not moving out. It's just traveling*," he says. Learning domestic tracks also helps reduce confusion about what you're looking at.

"*As boring as dog tracks might be, get to know them so you can eliminate them from more interesting tracks*," Brylinsky says.

Though understanding the ciphers left by animals may seem intimidating, there are several ways to approach the field. The first is by turning to the books. The instructors recommend 3 publications to assist amateur trackers:

- *A Field Guide to Animal Tracks* by Olaus Murie
- *A Field Guide to Mammal Tracking in North America* by James Halfpenny
- The Alaska Department of Fish and Game's Wildlife Notebook Series, available through the public communications office.

Once you know what to look for, get out there and start looking. "*Just start noticing, start looking for differences. Just start counting toes, Brylinsky advises.* "*And do it from your knees, not standing up. Because you see so much more from down there.*"

Though plaster casting is unwieldy and probably not worth your while, try photographing tracks you spot. Use a tripod or a fast film that will allow you sufficient depth of field. Then you can study the tracks at your leisure and with more care.

"*It makes you focus on the key things*," Brylinsky says. Good places to look for tracks and sign include any sandy beaches away from inhabited areas or thoroughfares.

"*If people go out to the Mendenhall wetlands, they'll be disappointed because all they'll see is dog tracks,*" he says. Check around mouths of rivers, which animals often frequent. Places like Eagle River and Point Bridget State Park offer a variety of habitats. Don't just stick to the trails; animals aren't likely to be where you are.

Along alpine trails, look for signs of lynx, coyotes, wolves and other rare animals. The moraine area and trails near the Mendenhall Glacier sometimes reveal evidence of their visits.

The snows of winter also offer an ideal canvas for tracks. Try Windfall Lake, the glacier, or even Eaglecrest. "*Winter's a really fun time especially because you see animal trails for a long time and you can really follow them*." Brylinsky says

If you want record your observations, he recommends index cards rather than notebooks, because it's difficult to dig out that important otter track spotting months or years later from a pile of filled notebooks. Jot down measurements, location, habitat, time of day and year, descriptions and other important details.

With enough observations, you'll start picking up the finer points of animal behavior. Most importantly, be patient. Don't expect to interpret long stories the first few times you spot tracks. "*A point will come when suddenly you'll start seeing things your partners don't, and you'll know you've come a long way*," Brylinsky says.

The reward? Perhaps someday you'll encounter something unique, something special, like the lynx trail Brylinsky discovered one winter near the Mendenhall Glacier. "*I spent hours following those lynx tracks. I wanted to find a kill site, or scat or something,*" he says. He didn't. But whenever he visited, he looked for more signs of the shy animal. That's the sign of a true tracker.

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References

2022: Listed first, below, are references used in our 1990s classes. Several have since become obsolete, but are still included to give a sense of the 'state-of-knowledge' at that time. This is, after all, a graphically historical document. Perhaps surprisingly, in view of how 'old-school' these field-arts were considered in the decade approaching Y2K, the modern arts-&-sciences of tracking have subsequently blossomed, thanks in part to groups like Cybertracker, and the South Sound Nature School, founded by former Discovery Naturalist and tracker Kevin O'Malley.

Hmmm, maybe those fears of 1999—that Y2K was about to blow us back into the stone age—ephemerally convinced suburban scientists and vegetarian pet lovers that tracking skills and mammalian autopsy were worth a closer look. Granted, we survived the millennial turnover, but next year's 911 was a doozey. Then 2020>21's shitstorm demonstrated to many that peaceful intermissions are getting shorter, while bellicosities both natural and 2-legged are growing meaner and longer.

Fear is a fickle motivator. Even more popular than Discovery's early tracking classes were our weekend Scoutcamp Wild-edibles overnights. When we asked incoming participants why they chose

Following the earlier references, a few more recent publications are listed.

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